Digital Literacy: Comparative Review on Machine Learning Based Performance Assessment of Students

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Abstract

The E-learning system paved an opportunity to make drastic changes in the educational system all over the world. Several institutions began to implement online learning to offer internet based courses contrary to the traditional classroom teaching. These online courses tends to provide several potential benefits such as flexibility and opportunities, to discover knowledge of the students. It also offers innovations in learning strategies of the students and resolve several complexities by accessing information from internet. Though e-learning based systems produces certain advantages, they also possess limitations of co-operative learning, active learning and performance mitigations. To address these issues, the present study focused on the different AI based techniques used in the prediction of student's academic performance. The main objective of the study is to analyze the primary factors that affects the learning through online and analyze the performance using different intelligent approaches. A comparative study of the AI based techniques is performed to analyze the different methods involved in the assessment of academic performance. Further, the present issues and future works of the studies is deliberated to produce optimized analysis systems. This tends to support several researchers to overcome the disputes and provide effective e-learning assessment systems.

1. Introduction

The concept of e-learning involved in transforming the higher education using disruptive technologies [1]. This e-learning concept is one of the differentiating tools, which are used by many universities because of their focus on the student interaction based on several technologies, and permits the students for accessing information in an easier manner [2]. Moreover, the concept of digital learning allows both the synchronous and the asynchronous learning modules, only having a viable access to the internet [3]. E-learning has an impressive growth with a reliable context to the advent of technological advancements, especially in the fields of education, by integrating them to the tripod, comprising technology, education and the economics [4]. Moreover, the modality of teaching presents the advantages such as low cost, deliberated allocation of time to study and self-management over each of the concepts. This enables the flexibility to be consistent and to be a standardized platforms [5]. By 2015, the market of e-learning was estimated up to 165 billion USD having an average annual growth range of 5%, from the year of 2018 to

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2023 [6]. The concepts of distant education have been resolved using the learning management systems, which are capable of employing various learning strategies such as tele-conferencing, pre-recorded films and many discussion-boards. The concept of education known as remote learning, involves in engaging students and the teachers to be physically apart and mentally more connected to the time of teaching and learning. Furthermore, e-learning are a mode of instruction, which effectively makes use of wide range of tools and the technologies to enhance the factor of student learning [7]. The importance of the e-learning in a contemporary form of education is enveloped with their technological aspects, market and the eventual replacement of the traditional forms of classroom sessions and instructions. Gyan Darshan is one of the 24-hour E-learning satellite channels, which was initiated by the that was developed by Indira Gandhi National Open University known as IGNOU, one of the largest Open University globally. The instructor-based training and e-learning, the benefit provided was 24/7/365 is clear. This is due to the course content being quick and are used for teaching and in the process of training after the generation, making the overall process of e-learning cost-effective [8].

This in turn facilitates the clear form of communication among the student and the teacher. The success rate of the e-learning is influenced by various factors such as learning environment, various learning resources and instructional strategies. Nevertheless, the concepts of Artificial Intelligence (AI), cloud computing and the big data are also evolving in the development of e-leaning environments. These platforms offer a better range of learning conditions and situations for online conceptual learning. One of the significant advantages of the e-learning concept are the availability of educational opportunity, gain of learning and the complementary means of academic accomplishments, these are some of the recognized and arte accepted parameters globally. The integration of technology into the education has been a prevalent concept around the world. Moreover, providing the access to the quality of education is one of the crucial challenges faced by the current developing countries. Thus, many of the developing countries have a prominent access to the quality education which are one of the potential challenges faced by many of the developed and developing countries. As a result, many developing countries has been with a limited thought of implementing the technology towards education. But these situation have drastically changed after the hit of COVID-19 globally [9].

The traditional mode educational systems and practices are not available as they had in the period of before pandemic [10]. This made most of the countries to shift towards a technological educational system paradigm, being a primary and a primitive source to deliver education and for knowledge Transfer. Since then, many developing countries adapted and are used in the technologies in the educational sector under various capacities among varying educational levels in aspects of delivering a conceptual and an intellectual mode of education to the students and practitioners. Since the development of digitalized education in the 21st century, the interaction among the computer and the human among a virtual environment has aided in enhancing the learning experience for both teaching and learning [11]. The satisfaction from the learner, and the effectiveness of learning are closely dependent on each other to the intelligent engagement, which is one of the vital parameters, lies majorly for influencing the quality of the online courses. The need for support upon both teaching and the learning via online platforms popularized both the e-learning concept and the developing countries during the period of pandemic, where lockdowns are the only orders being followed. Additionally, reduced expenses for education, timely and higher quality of information accessibility and flexibility of education being a prominent convenience and benefits from e-learning that most of the universities in the developing countries realized [12].

One of the novels and the difficult approaches in the e-learning lies in combining various teaching approaches. Thus, adopting the online learning methods can alleviate the chances of academic staff deficit, can be used in scaling the pedagogical reforms and in increasing the career possibilities of each graduates [13]. Whereas e-learning platforms prone to deliver the education to most of the educational institutions, globally. One of the crucial phase of e-learning is that, the e-learning domain is not well researched which in turn affects the students adoption levels and the e-learning technology [14]. Students make use of e-learning tools which are crucial to their success. If each of the students refuse to the advantages of e-learning tools and platforms, the overall effectiveness lying in the e-learning becomes questionable [15]. One of the key factors of success rate from the use of e-learning platform is, how they are adapted and are used. The innovative utilization of the e-learning platforms refers to the manner by which the students make use of each of the e-learning components, in a fresh and at varying approaches [16]. Thus, many researches make use of these e-learning platforms were the concerns regarding the slow adoption of each e-learning task are linked to the insufficient technological resources and the unwillingness by the government sectors in prioritizing the digital leaning platforms. The government sectors are indecisive towards the commitment of enhancing the education practices, which is to blame the country, for their delayed

acceptance of the e-learning [17]. In Libya, most of the student population are prone to use smart phones, which are smaller in screen size and are with lower capability of storages, which makes a difficult task for them to effectively support e-learning modules [18]. Moreover, the erratic connectivity of the internet has been blamed for the snail pace rate of adapting the e-learnings practices in developing countries [19].

Furthermore, the faculty members of an institution have a finding that the social presence during teaching influences the evident usefulness, the effective ease of use and an overall satisfaction of using an e-learning environment which are highly prominent to the achievement rate of Quality of Education from SDG4. Thus, by promoting the social presence among the faculty members, the e-learning environments are more engaging and collaborative. This in turn makes the enhancement in the overall quality in educational experience. Moreover, by promoting a confirmed usefulness and the ease of use among the e-learning can aid the students in enhancing their skill sets and the acquired knowledge rate for a success in the future workforce, which in turn indirectly contributes to the SDG4 objective, by ensuring an inclusive and an equitable quality of education to all of the students pursuing education. One of the findings that the faculty members who confirm their social presence makes an influence, by suggesting an investigation over the faculty development can aid in the e-learning contributing to a great job and career opportunists, with an increased job satisfaction and retention. This ultimately benefits both the students and the broader range of educational community. Thus, these findings highlight the importance of investing in the social presence among the faculty individuals among the e-learning environments to promote a higher-quality of education and contributing a higher success rate factor in career and to SDG4 concepts. But these concepts had a mild range of dis-satisfaction and confirmed usefulness [20].

The review examines the innovation application of ML in assessing student performance, highlighting its potential to enhance education outcome. The novel perspective by examining the critical role of faculty social presence in enhancing student engagement within e-learning. By comparing various models, like RF, SVM, XGBoost, the study reveals how these technologies can improve predictive accuracy. It emphasizes the importance of integrating ML with traditional assessment methods to foster personalized learning experiences, ultimately aiming to advance digital literary and ensure quality education for all students.

1.1. Paper Organisation

The review of performance analysis of students under e-learning environment is performed initially with the introduction and survey methodology in Section 2. The evolution of e-learning, significance of performance assessment is deliberated in Section 3 and 4. Whereas, the traditional approaches along with its drawbacks is discussed in Section 5. Further, the emergence of AI techniques involved in performance assessments of students is reflected in Section 6. To analyse the effects of AI in performance analysis, the comparative study of AI based performance evaluation is done in Section 7. Moreover, the critical analysis, research gaps, present issues and future recommendations are projected in Sections 8, 9, and 10. Finally, the paper is concluded with Section 11.

2. Survey Methodology

The "Google Scholar" is used to generate the survey methodology phase. The terms used in searching the papers are "Performance Analysis of student's in e-learning", AI techniques in performance assessment of student's in e-learning environment. The related and suitable publications are collected from papers published between 2019 and 2023. At first, the title related papers were selected and abstract screening was performed. If the context is associated with the concept, then the related studies with overall test was also considered. Finally, the citations of the present paper is examined and comprised as required with the total refined studies of "45" corresponding to the relevant context. The pictorial representation of survey methodology is shown in figure.1.
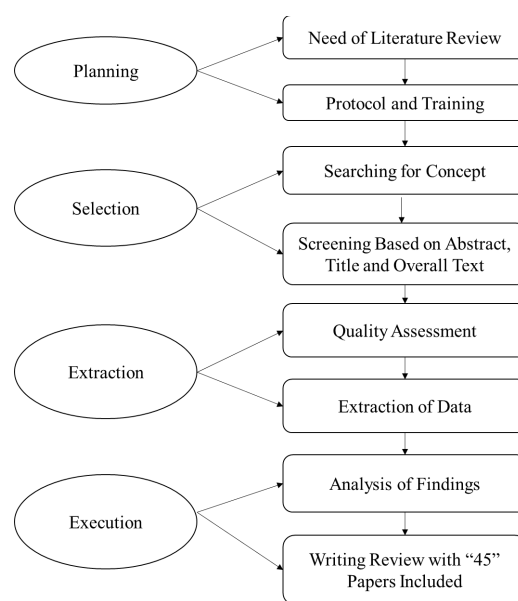

Figure.1 Survey Methodology

3. Evolution of E-learning

The concept of e-learning is defined to be the self-placed and are to be real-time online form of an internet based learning, which lies in a relation to the end user [21]. Nevertheless, the e-learning is also defined to be distance learning, which is one of a primary methods in instructing the universities, and the other higher institutions, especially during the period of COVID-19. Some of the surveys indicated that the 85% of universities had used the e-learning concepts as their primitive teaching and learning model during the pandemic times [22]. Though, there are various debates regarding the exact definition and the scope of e-learning. Thus, for the purpose and understanding the e-learning has a broad range of scope focusing especially on the online based education and are being a real-time delivery for both training and for providing education Over the use of the internet sources directly the end-user device without any of interruption [22].

The concepts of online form of learning involved the interaction from both the end via a digital and an internet based technology which is pervasive and are multi-faceted. This evolvement creates more of opportunities and challenges for the educational research aspects in the wake of pandemic era. In prospects of these issues, the advanced interdisciplinary agenda upon the online learning approaches. This is where the intersection of educational technology, the psychology related to education and the learning sciences are adjoined [23]. The use of multi-media tools and the technologies with the internet for the learning aspects are considered as a mean of enhancing the accessibility and the efficacy of the education which are related to quality of education. This is done by enabling the access to the resources and the services, which in turn facilitates the remote exchanges and the collaboration. The e-learning concepts are one of the innovative and approach which are well-designed and are learner centered, creates an interactive learning environment to individuals. This is done with regards to the time and the location using the internet and the other updated digital technologies, with alignment to the instruction and designed applicable principles. Whereas, in essence, the combination of internet, education and the electronic media is defined to be the e-learning. Moreover, the developed nations with a particular leverage in the e-learning is adapted to extend the educational opportunities to each of the communities, which were previously excluded [24].
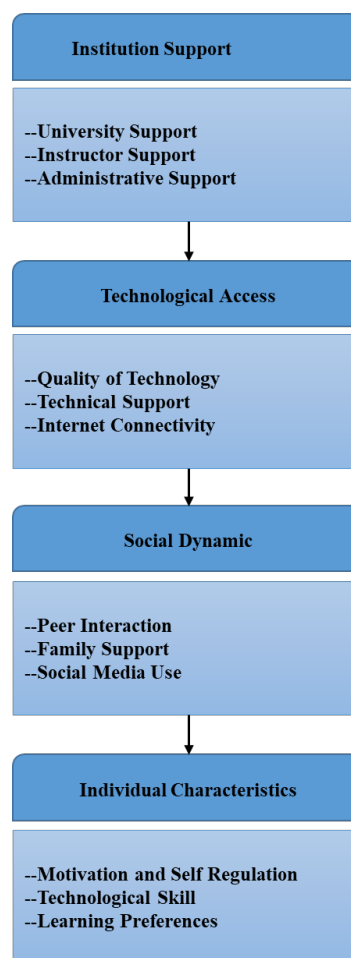

Figure 2. Factors Affecting Online Learning during Covid-19

The figure 2. Depict the transition to online education during the pandemic has been shaped by several key factors categorized into four areas, the institutional support, technological access, social Dynamics, and individual characteristics. The institutional support include the resources in university, instructor engagement, administrative policies. And the technological access involves the quality and reliability of technology used for learning, availability of technical support, and internet connectivity. Social dynamics encompass opportunities for peer collaboration and communication, the use of social media sharing educational resources. Finally, individual characteristics refers to student motivation ad self-regulation, proficiency with digital toll and personal learning preference.

According to development in technological fields, the overall educational system and the teaching practices are also updated. Whereby, at the end of the 20th century, the system of e-learning was said to be a means of learning using the essentialities of internet resources and multimedia. The evolution of

e-learning can be paralleled with the track development of the internet, their design, and content. Currently, the concepts of e-Learning envelopes wide range of field concepts and tools such as, mobile learning, applicable modules, and blended form of learning. This includes fast learning, scrolling telling, quiz sessions held online and webinars. Other such concepts like, interactive video sessions, Nano-learning, are also implied via e-learning. In context of these proliferation standardization bodies of educational and research sector are constantly working to enhance and to finalize the quality of standards which should be highly respected and adapted by the institutions using e-learning platforms. Moreover, the employment of an online based training and learning system are in need technical intervention, human knowledge, and effective pedagogical resources. These should be synergized and should be able to provide education to each of the distant learners. To achieve this respective priority, it is one of the potential aspects to control the requirements which are related to the device to make more use of it [25].

Many of the academic institutions are relied excessively upon the traditional form of teaching practices. But once after the pandemic times, each of the educational domains are said to shift towards the emergence mode of online teaching concepts [26]. This is due to the fact that these concepts are separated and are unintegrated with two probabilistic negative effects. Initially, the students and the teachers experience the solutions at varying contexts, where the educational community from various university departments, from teachers to the students, whereby the digitalization of the subjects focused only on the concepts of learning in new aspects and in redefining each of the domains. Since these solutions are separated and are fragments, both the students and the teachers experienced the same in various digitalized tools, which limited themselves in sharing a digitalized learning space [27]. Followed by, this separation should be constituted to a hindrance, to innovate a new learning forms, which was echoing each of the traditional patterns such as lectures and reading books. Thus, the overall separate processes are simulated using the incremental improvement which failed in creating a disruptive changeovers [28].

4. Significance of performance assessment in e-learning

During the COVID pandemic initiated in Wuhan city, by 2019, made a drastic effects upon social distancing which created a huge impact on each of the sectors such as industries, education and in business sectors. The education is one of the most affected sectors in the pandemic times. Nevertheless, the various development in the

technology has implied a positive impact over the educational sectors in aspects of delivery and in qualifying the educational system. The significance provided by the e-learning has been a potential advantage which aided each of the students to pursue the education without any breakouts. Alternatively, during the times of pandemic, all of the work and the educational culture were changed from campus to the home based learning. This had a massive change on the teaching and the learning which are based on the present economic factors, and unstable forms of network connectivity. But the positive parts of significance created by the e-learning modalities, tutorials in video formats and the other essential experimental simulations such as online examinations, consultations, online courses and the necessary motivation features for the enlighten the career of students [29]. This study concluded that the students are motivated by the digital learning process which aims in achieving their learning goals. Moreover, the impact of digital marketing upon each of the student perspective have been discussed in the study. A discussion upon the perspective of teacher is followed. Furthermore, teaches faced number of challenges during the implementation of the digital form of learning platforms. The conventional study has explored the readiness of the faculties to teach via digital modules for classroom sessions. These sessions are interpreted based on three various aspects such as the pedagogical, physiological and the technological aspects. Similarly, the suggested study [30] was investigated based on the self-perception and the ability for the adaption of digital form of learning phases among professors. The quantitative approach for the study resulted in a positive influence, upon the digital competence and the levels of self-confidence were increased upon the adaption of digitalized learning.

Whereas, this suggested approach has been with a perceived interaction, the other educational materials and the perceived use of digitalized platforms in Saudi Kingdom, during the pandemic, and their analyzing upon the students satisfaction using the e-learning modules. The study has been completely based on the structural equation modelling (SEM), and the effective route analysis. These were done using the data collection from an e-learning user. According to the statistics from the study, both the Student happiness and the yearning to make use of e-learning had a positive impact on actual use. The perceived interaction and the self-efficacy were to be the potential factors influencing the perceived usefulness and ease of use, which simultaneously affected the student intentions and the satisfaction from e-learning [31]. Correspondingly, the suggested approach has intended in exploring the relationship among the relationship among the service, e-trust and the quality with the e-loyalty in areas of Vietnam, which

is one of the developing countries. The results have deliberated that both the e-trust and the e-learning practice were best in supporting the e-learner privacy means. Besides, these parameters has a significance relationship among the security of e-learner providing them with best educational quality [32].

Concurrently, the state-of-art approach intended in analyzing the development of both information and the technological means has a significant impact on the e-learning topologies. The effectiveness of the e-learning modules in the multimedia classes in enhancing the vocational student learning phase achievement and in motivating them were analysed. The quasi-experimental method has been intended for the study especially for class 10, students from veteran school, central java. The results from these experiments have stated that the e-learning significantly enhances the student achievement and the motivation of students among the network subject and increases the student participation in the e-leaning platforms [33].

Whereas, the suggested approach intended in analyzing the student emotional well-being and the interaction among carious e-learning modalities and platforms. This study also examines the student academic performance with context to the mentioned parameters. This is done critical for the complete assessment of future skill development. These were examined using various ML and DL approaches combinations and using the Student Academic Performance Predicting (SAAP) analyzing tool for the interpretation of the overall outcomes [34]. Online interaction is positively contributed by the online instruction which has a positive contribution to the prediction of overall student education outcomes. Both the student learning and the online interaction were dependent among each other having a positive correlation [35].

5. Traditional Methods Involved in Performance Analysis

The study represents the data mining approaches in analyzing the student performance. Association mining and classification are used in the aspects of predicting the performance of students, before an examination session. The prediction of final grades of semester are done in prior. This in turn results in minimizing the dropping rates of students. Further, an extra rate of attention can be provided to poor performing students. Thus, the prediction of students' performance will aim in alerting the learner to analyze their performance and providing a chance to improve their performance in future. The instructional objectives which can be tracked using the narrative records, from an observed behavior is analysed in the suggested study. This narrative is

recorded in written record. These records are appropriate for complex behaviors, which are effectively described using a checklist. The observation would initiates with a purpose, such as student performance on a team when performing an activity. Likewise, the application related tasks such as analysis, are also analysed using the traditional practices. They ranking and scoring are relied to effective analysis to envelope a wide range of material. However, these are difficult to write well, and devoid of making a required frame of response. Student evaluation are done on the basis of measurements and results. Among these, the evaluation are done based on either a checklist or using a rating scale. The evaluation are devoid in absence of tests and objective information.

5.1 Drawbacks of Traditional Assessment Methods

Conventional methods like manual techniques are considered to be time consuming, daunting, tedious and can be prone to blunders. It is primarily due to strength of students in university or colleges. Therefore, an efficient and effective model should be built for assessing the performance of the students using AI techniques, as AI techniques possess various advantages such as speed, delivering better accuracy for the model and provide desired outcome for the users. Implementation of AI technologies over manual techniques assist the teachers and the institution for analyzing and assessing the performance of students with ease.

6. Emergence of Artificial Intelligence (AI) in Performance Assessments

E-learning has become significant approaches used in the development of student's knowledge. In recent years education is not narrow-downed or restricted to only conventional classroom teaching but it goes beyond certain aspects like OES (Online Education System), seminars, workshops, MOOC course, WBES (web based education system). Further, it is considered to be more challenging for predicting the performance of the students due to huge bulk of data stored in educational DB (Database) and LM DB. However, different methods can be carried out for assessing the performance of the students which includes incorporation of DM (Data Mining) techniques, as DM techniques are considered to be prevalent techniques which are used for evaluating the performance of the students and is widely used in educational sector. Different DM techniques like classification, feature selection and prediction can be employed for assessing the

efficacy of the model for performance assessment of students. Hence, different classifiers such as MLP, SVM, and DT were used in the existing study for assessing the performance of the students. In addition, different multi-classifiers are used for classifying the performance of students. This capability allows for personalized learning experiences tailored to individual students needs fostering engagement and improving education outcomes. Similarly, suggested model has employed DL techniques for assessing the academic excellence of the students by employing DL models. Therefore, recommended study has utilized DNN along with ML algorithms. The classification process was carried out by using DNN, in which the data was separated into training and testing data. Moreover, the scalability of these AI-driven solutions ensures that as student populations grow, the ability to monitor and support academic performance remains strong. Then, NN has been plotted by employing neuralnet approach, which was then created by using DL methods of 2 HL along with ReLU activation function and then the one output layer was used by employing activation function. Further, fine tuning process was carried out for making stable changes, by providing accuracy of 85%. The application of AI and ML in assessing student performance not only addresses immediate challenges but also lays the groundwork for sustainable improvement in education. By enhancing virtual learning environment, facilitating personalized learning pathways and providing scalable solutions, these technologies can significantly contribute to long term educational success beyond the Covid-19 pandemic [36].

6.1 Examining Student's Performance Using Machine Learning

Predicting the academic performance of the students is considered to be one of the significant aspects for parents, management in higher sector and students itself too. Therefore, selection of right and correct academic program is significant can save efforts, save time and other resources for both educational institutions and parents. Therefore, in order to accomplish in forecasting the academic performance of the students, different algorithm are used by different studies, and the selection by incorporating a wider range of algorithm such as RF, SVM, NN, to improve the accuracy. Similarly, suggested study has employed IDSS system (intelligent decision support system) for predicting the performance of the students prior to the admissions in any academic program or getting promoted to the higher classes in academic program. In addition, suggested study has employed decision tree based algorithm called LMT (Logistic Model Tree) for learning the intrinsic relationship between the student's academic grades

and detected features. Further, the employed model has been trained and tested on dataset which is considered as real world dataset with record records of 1021. The suggested model aided in designing a flexible framework for extracting and mining the concealed intrinsic relationships amidst the academic performance of the students and the characteristics of the students. Likewise, recommended study has emphasized on the academic performance of the students, as the academic performance of the students is considered to be utmost important and crucial aspects for any students to sustain this world. Therefore, the suggested paper has analyzed the past results of the students for improving the performance of the individual students. Hence, the paper has examined past outcome of the students which included the attributes of the students and then the data is trained using ML tools. Three different ML models were used in the recommended model, which included LR (linear regression) for supervised learning and LR with DL and, then the neural network has been tested by trained and tested, however, from the experimental outcome, it was identified that, LR with supervised learning best outcome for attainting better MAE rate for assessing the performance of the suggested model [37]. Likewise, the performance assessment of the students could be enhanced by employing different other techniques, therefore, suggested model has employed four different ML classifiers for building a classification model, which aided in delivering better outcome for assessing the student's performance of the model. In addition, ML techniques like NB, DT, LR and ANN also used in the recommended study. The study has also focused on paying extra attention to the effect of employing internet as a learning resource and the consequence of spending time on network while using internet for learning purpose. The model employed in the study utilized ROC index for measuring the efficacy of the existing framework. Further, various existing methods have been considered for measuring the performance of the existing techniques such as accuracy, precision, recall and F1 score in addition classification error is considered to be one of the primary metrics which needed to be evaluated for assessing the efficacy of the recommended model [38].

Various existing studies have been performed for identifying the factor which affected the learning and performance of the students. These prevailing methods aided the students for travelling in the correct direction and to modify the habits and personal situation for the better students. Therefore, the rise of virtual classrooms helps in monitoring the students and use of online resources have permitted teachers for identifying the leaning habits of the students and helps in examining the reasons for academic progress of the students. Therefore, the

existing study has utilized different ML techniques for assessing the performance of the students by employing tree based ML techniques, Different types of NN and ensemble based learning. The tree based ML techniques included DT, RF, XGBoost and types of NN included were hopfields network, MLP, competitive learning network, simple perceptron and CNN. Therefore, the primary objective of the existing model is to apply the model to a dataset which contained data form a virtual environment and assisted in constructing the performance models, which permitted to forecast if a student is going to pass or fail in the academic year. Eventually, the factor which exhibited the highest influence on the performance of the student were detected and suggestions were provided for improving those aspects in order to accomplish an upsurge the pass rate amid the students [39].

Performance evaluation of student is considered to be significant for checking the practicability of development. Hence, frequent assessment helps the students in comprehending the progress of the work and also helps in assessing, where the students are lacking. However, manual methods for analyzing and assessing the performance of the students can be a tedious, daunting and challenging tasks, since lot of effort is needed to complete the evaluation process of students, as institutions may comprises of have lot of students. Therefore, the suggested study has employed automated solution for evaluating the performance of the students by employing ML techniques along with DL techniques. Hence, the suggested study encompassed of amalgamation of SVM, ANN and K-means clustering techniques. The amalgamation of K-means clustering with ANN and SVM helped in completing the evaluation procedure over MATLAB simulation. The main objective of employing classification algorithm in the recommended model was to assess the performance of the student with the aim to minimize the human effort. In order to assess the efficacy of the model, different metrics such as MSE. However, from the experimental outcome, it was identified that MSE was 5-20% better than the estimation of effort needed for assessing the performance [40]. Similarly, ML based systems deliver better outcome for assessing the performance of the students as ML classifiers are more efficient, deliver better results than the existing techniques. Therefore, the suggested model evaluated the performance of high school students during semester and helped in identifying the most important factors which affects the performance of the students. Therefore, different classifiers have been used in model such as LR, SVM, RF and ANN models. In addition, Boruta algorithm was employed for calculating the significance if the features which were fetched from teachers and drawn one by one via online questionnaire method. The developed model aided

in evaluating the performance of the students promptly and also aided in evaluating it without any bias or other intentions which made the system impressive [41].

VLE (Virtual Learning Environment) like blackboard and moodle helps in storing vast data for identifying the performance of the students and also engagement of the students in certain activities, by doing so, the better outcome could be fetched for assessing the performance of the students. Therefore, various studies have employed different ML models for analyzing the performance of the students, which aids the educational institutions in analyzing the situation of the students and the needs and wants of students for improving their performance. Hence, suggested model has utilized hybrid ML framework for predicting the performance of the students using eight classification classifiers such a NB, DT, RF, KNN, one, j48, SVM and JRip. In addition to the existing ML methods, different ensemble methods have also used in the recommended paper such as bagging, voting and boosting for determining the best performing predictive model. Further, filter based and wrapper based approaches have been employed for feature selection process. This filter based techniques helped in selecting best features of the datasets which were associated to performance of the students. From the experimental outcome, it could be identified that, ensemble model helped in increasing the predictive accuracy of the model [42].

Academic performance of the students heavily depends on innumerable dynamics like academic progress, behavior of the students in terms of learning new activities or personal characteristic of the person. Therefore, the recommended paper investigated the performance assessments of students by considering ML techniques for predicting the final grade point average depending on personal characteristic like entry score obtained in university, gap year and academic performance of the students in each year and so on. The data, which has been fetched by conjoining data from survey of graduate students of 3 different years and the data obtained from SMI (Student Management Information) of the university. Hence, an empirical study has been conducted on student dataset at a Vietnamese university as suggested study has employed ML techniques for assessing the performance of the model. From the result, it was identified that, findings obtained from the suggested study aided other higher education institutions in Vietnam with regard to forecast final academic results of students and consequently deliver students with necessary support from university admin and lecturers. Further, the output obtained by the model helped in incorporating MIS of a university to afford premature caution to students who are at risk [43]. Likewise, achievements in academics of students is

considered as a huge area of concern for most academic institution. Therefore, vast usage of LMS spawns enormous number of data about learning as well as interactions of teachers. The data stored in the LMS encompasses if hidden knowledge which aids in developing the academic performance of the students. Therefore, suggested study has employed prediction algorithm for assessing the performance

of the students in academia which has been developed in accordance with clustering and classification approach. The process involved in the recommended study has been pre-processing of data, then selecting the features using different aspects like demographic features, academic features, behavior features and other features. once the features were extracted DM classification algorithm was applied which encompasses of SVM, NB, DT and NN classifier after which input is

considered and then K-Means clustering approach is utilized for predicting the academic performance of the student. The outcome attainted from the suggested model resulted in developing a patting relationship between behaviour of the student and academic performance of the students. Furthermore, resulted obtained by recommended hybrid approach (clustering + classification) was better than the existing models in prediction of academic performance of the students [44].

Table 1 Comparative Analysis of AI based Performance Evaluation in E-Learning

Sl. No	Reference	Objective	Methods	Results	Limitation
1.	[39]	For identifying the leaning habits of the students and helps in examining the reasons for academic progress of the students	Various ML techniques for performance analysis, including ANN.	Different ML techniques were used for assessing the performance of the students by employing tree based ML techniques, Different types of NN and ensemble based learning. The tree based ML techniques included DT, RF, XGBoost and types of NN included were hopfields network, MLP, competitive learning network, simple perceptron and CNN.

Therefore, the existing model aims to utilize these techniques on a virtual environment dataset to predict students pass or fail outcomes for the academic years. | Limited focus on the diverse ML techniques may restrict the analysis. |

2.	[42]	To analyze the situation of the students and the needs and wants of students for improving their performance	Hybrid data mining approach combining various ML algorithms for performance prediction.	Suggested model employs a hybrid ML framework with eight classifiers such a NB, DT, RF, KNN, one, j48, SVM and JRip. Along with various ensemble methods to identify the best predictive model for student performance. Further, filter based and wrapper based approaches have been employed for feature selection process From the experimental outcome, it could be identified that, ensemble model helped in increasing the predictive accuracy of the model [42]	The reliance on specific algorithms may overlook other effective methods for performance prediction.
3.	[40]	To assess the students frequently in order to help the students in comprehending the progress of the work and also helps in assessing, where the students are lacking	ML and data mining approach for analyzing student performance.	The suggested study utilizes an automated solution combining ML and DL techniques, specifically integrating SVM, ANN and K-mean clustering for student performance evaluating through MATLAB simulations. The main objective of employing classification algorithm in the recommended model was to assess the performance of the student with the aim to minimize the human effort. In order to assess the efficacy of the model, different metrics such as MSE.	Limited exploration of the impact of external factors on student performance prediction is noted.

4.	[43]	To assess the performance of the students by considering ML techniques for predicting the final grade point average depending on personal characterisc like entry score obtained in university, gap year, academic performance of the students in each year and so on	Empirical study using various machine learning techniques for predicting academic performance.	An empirical study has been conducted on student dataset at a Vietnamese university as suggested study has employed ML techniques for assessing the performance of the model. From the result, it was identified that, findings obtained from the suggested study aided other higher education institutions in Vietnam with regard to forecast final academic results of students and consequently deliver students with necessary support from university admin and lecturers.	The study may not account for the dynamic nature of student behavior over time in predictions.
5.	[44]	Prediction algorithm for assessing the performance of the students in academia which has been developed in accordance with clustering and classification approach.	Hybrid data mining approach combining various ML algorithm for performance prediction	The process involved in the recommended study has been pre-processing of data, then selecting the features using different aspects like demographic features, academic features, behavior features and other features. Moreover, K-Means clustering approach is utilized for predicting the academic performance of the student. The outcome attained from the suggested model resulted in developing a patting relationship between behaviour of the student and academic performance of the students.	Hybrid approaches may complicate model interpretation and increase computational requirement.

| 6. | [37] | To predict the performance of the students prior to the admissions in any academic program or getting promoted to the higher classes in academic program. | Analysis and prediction of student academic performance using multiple ML models. | Decision tree based algorithm called LMT (logistic model trees) for learning the intrinsic relationship between the student's academic grades and detected features. Further, the employed model has been trained and tested on dataset which is considered as real world dataset with record records of 1021. The suggested model aided in designing a flexible framework for extracting and mining the concealed intrinsic relationships amidst the academic performance of the students and the characteristics of the students. Likewise, recommended study has emphasized on the academic performance of the students, as the academic performance of the students is considered to be utmost important and crucial aspects for any students to sustain this world | Potential overfitting due to small sample size in training data can affect generalizability. |

7. Critical Analysis

An analysis of several performance assessments of students under e-learning circumstances is performed. The AI based techniques such as LR, SVM, NN, DST, RF, NB, ANN, k-means clustering are used in the performance analysis of the e-learning based criteria. Nearly, 45 papers are referred and screened for analysis. Figure.2 denotes the AI based methods used in the assessment of student's performance.
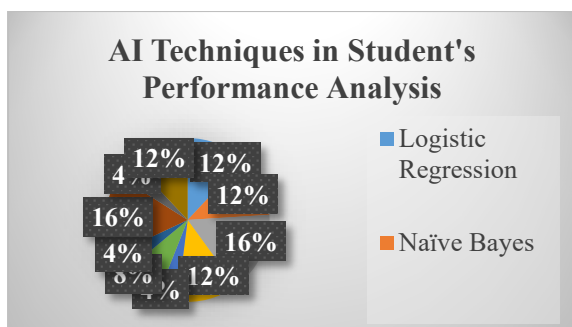
Figure.2. AI based Approaches Used in Performance Assessment of Student's

From analysis, it is inferred that most of the studies involved ML based algorithms in the analysis of student's performance. When compared with other algorithms, a maximum number of studies applied SVM, DT, RF, LR and ANN. Further, the year-wise analysis of studies used in the present work is represented in figure.3.
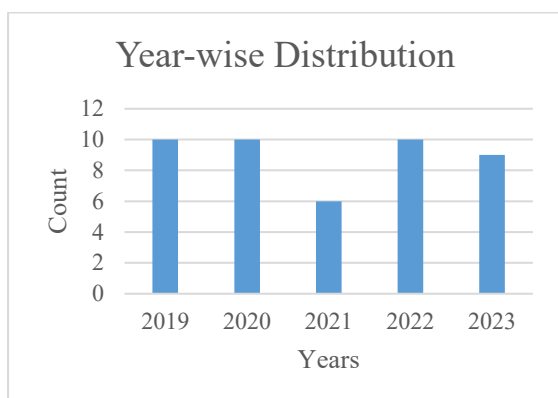

Figure 3 Year-wise Distribution of Papers

The present study involved papers between 2019 and 2023, where 45 studies are considered as per the survey methodology. From figure.3, it is identified that most of the studies are taken from the years 2019, 2020, 2022 and 2023, denoting conventional studies of these years highly concentrated in student's performance analysis. Whereas, there is still research gap to be filled in recent years and further implementation of various techniques in the concept of performance analysis of e-learning students is significant.

8. Research Gaps

In contrary with the significant advantages of digital learning, students also face some challenges causing negative or limited results. From analysis, it is found that the e-learning is considered to be less effective due to the lack of face-to-face interaction encounter with teachers or instructors. In e-learning, the assessment methods are involved through online and these methods reduces the probability of restricting the illegitimate activities like cheating and other illegal actions. Due to this lack of essential personal involvement is the main drawback of e-learning, which is not only common among colleague learners but also between learners and instructors. Another drawback of e-learning is maintaining motivation, the student with lack of self-motivation reduces the success rate as compared with their counter parts. Moreover, the lack of self-regulation leads to tendency not to assign sufficient time period for completing the assigned tasks and thus providing poor quality work. Consequently, the students suffer a lot in assessing the motivating factors in order to maintain momentum of throughout the duration of the course. Some of the research gaps are mentioned that are illustrated by various studies.

An empirical study has been performed by using ML based approaches on student dataset of Vietnamese University. The outcomes have projected better analysis of student's performance, but the study lacks in classification using imbalance academic datasets. So, the study must be improved by dealing with imbalanced problem in academic dataset by enhancing the prediction quality [45]. Similarly, the study has applied different ML techniques such as several types of NN and tree based models. The study has focussed on developing the prediction model of students. The factors that affect the performance of the students has been predicted in this study. But the study should focus on determining the duration of student's participation under a virtual classroom as repetitive access for short time does not produce success [39]. The another gap in existing research are, hybrid ML based technique has been implemented to detect the performance of the students using eight classification approaches long with three ensemble methods such as voting, bagging and boosting. Even, the analysis of student's risk of dropping a course is also a significant factor that affects the performance of the students. So, the study should perform analysis of these fields and test the framework in a larger dataset. This tends to optimise the performance and analysis of the process [42].

9. Present Issues and Future Recommendations

Due to the pandemic situation, a great public health concern raised with public health challenge globally. This made closure of some educational institutions and were directed to involve timely and important amendments in the current educational systems. Though several studies indicated that students get

admired to the transition of learning systems, they also possess some challenges.

Online learning can be overwhelming. Leading to increased stress due to a heavier workload and difficulties in maintain self-regulation and self-motivation. Many students struggle with time management skills, which can exacerbate these feelings. Additionally, a lack of technical knowledge and the challenge of adapting to ever evolving technologies further complicate the learning experience. Educators also face the challenges of implementing effective assessment techniques to accurately analyze student performance in this dynamic environment.

From reviewing several studies, it is understood that academic performance analysis has been negatively affected. So, there is an urge to mitigate the performance and satisfaction level of the students. It is obvious that different researchers have put their efforts in investigating and establishing the theoretical concepts by using various models. But these methods lack in identifying the factors that influence the low performance of students and ways to mitigate the issues. So, an optimised analysis system of AI based methods with enhanced precision is crucial to predict the academic performance of students under virtual learning.

10. Conclusion

The student's performance analysis in e-learning circumstances is significant to predict the challenges accompanied in the development of knowledge. Though online courses offers several benefits, the students also face some issues. To mitigate these problems, the present work reviewed several traditional and AI based approaches involved in the academic performance analysis of student's. A comparative analysis of different AI based techniques was deliberated with their corresponding outcomes. Additionally, the study also projected the critical analysis based on the concept of "AI based techniques in the performance assessment of student's" and "Year-wise distribution of studies". Further, the research gaps were analysed from the studies and deliberated along with the present issues and future works. It was observed that the online learning is as effective than classroom learning, but there are essential portions that has to be overcome and make e-learning more optimised. This present study attempted to divulge the challenges in ensuring the efficacy of e-learning, which tends to guide several researchers in the enhancement of different approaches.

11. Declaration

- **Conflict of Interest:** The author reports that there is no conflict of Interest**.**
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